Developing a Site-based Hazard-rating System for White Pine Blister Rust in Ontario

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Introduction

White pine blister rust has spread throughout the range of white pine in Ontario, causing high levels of infection and mortality in many plantations and natural stands (Forestry Canada 1993, Morse 1981, Haddow 1961). A recent survey of industry and OMNR foresters and forest science client groups ranked white pine blister rust the third-most important of 31 white pine management issues (Morneault *et al.* draft).

Hazard-rating systems

Many studies (e.g. Van Arsdel 1961, 1965; Van Arsdel *et al.* 1956, 1961) have related site and climatic factors to disease incidence. Infection of white pine occurs through the needles in late summer or early autumn during periods of cool temperature and high relative humidity. Occurrence of these micro-climatic conditions is influenced by a variety of factors including site elevation, topography, associated vegetation, soil moisture, and regional mean temperature during the infection period. Several attempts have been made to use various combinations of these factors in developing hazard-rating systems to assist in reducing the impacts of WPBR. For example, in 1961, Van Arsdel (1961) created a hazard rating system for Minnesota, Wisconsin and Michigan, based largely on elevation and topography. In the mid 1980s, Gross (1985) used climatic data for the Great Lakes basin, linked to Hills (1959) site districts, to produce a broad hazard zone rating system for Ontario. At the same time, Lavallée (1986) combined elevation, temperature data and forest type to create hazard zones for Quebec.

More recently, Geils *et al.* (1999) reported efforts to construct a hazard-rating model for an area in New Mexico. Their model incorporates elevation, plant association and topographic position. They stated that future efforts to refine the model could include factors influenced by silvicultural treatments, such as current vegetation, stocking, or crown density.

The Need for Site-Based Hazard Rating

Gross's (1985) hazard zones for Ontario, although meaningful at the landscape level, have limited application at the stand level. Most of the white pine silviculture in Ontario is carried out in high to severe blister rust hazard zones. Although recent studies have documented 96% disease-caused mortality over 6 years in two young plantations in northeastern and central Ontario (Meyer, unpublished data), white pine survival is reported to be high in many other locations within these zones. Conversely, some white pine plantations in the low hazard zone have been severely damaged by blister rust (Bob Sinclair, OMNR, *pers. comm.*). In these cases local climate factors appear more influential than the regional climate.

Application of hazard-rating systems at the site level requires greater refinement and local input in order to correctly identify and weight the various factors influencing infection. For example, Van Arsdel *et al.* (1961) found that in Wisconsin, site factors such as topography, aspect, and canopy opening size significantly influenced the incidence of disease in low to moderate hazard zones, however, these factors were less significant in the higher hazard zones. An Ontario survey of 20 young white pine plantations in the North Bay and Temagami districts reported highest disease incidence in level areas and at the base of slopes (Forestry Canada 1993). Successful establishment and growth of white pine on sites located within the landscape-level severe and high hazard zones may be possible if we can accurately assess disease hazard at the site level and provide recommendations on how to reduce the hazard.

The Development of Site-Based Hazard Rating in Ontario

In 1989, the OMNR published guidelines for the management of white pine blister rust (Hodge *et al.* 1989). These guidelines are based on extensive studies carried out since the 1950s (mostly in Wisconsin and Michigan), and observations and surveys in Ontario. Decision keys in the guide assist the user in generating site-based hazard ratings based on such factors as local topography (aspect, slope position), soil texture and moisture regime, and ground vegetation. These guidelines were never validated in the field throughout the range of white pine management in Ontario, and the relative significance of various site factors was not determined [Jennifer Juzwik (co-author of 1989 OMNR guidelines), *pers. comm.*]. In 1998 some of the information from the 1989 guidelines was included in the OMNR's silvicultural guide for managing conifers in the Great Lakes-St. Lawrence Forest Region of Ontario. The 1989 publication is no longer widely used (Fred Pinto, OMNR, *pers. comm.*).

The development of the Ontario Climate Model and the Digital Elevation Model (DEM) for Ontario has increased the resolution of both climatic and topographic information in Ontario (Mackey *et al.* 1996). Venier *et al.* (1998) linked these models with historical distribution data of Scleroderris canker in Ontario to produce a spatial, climate-determined risk rating system for the disease. Similarly, it may be possible to use from these models, along with field survey data, to predict site-specific blister rust hazard.

Our Current Project

Our long-term aim is to create an interactive decision support tool to assist white pine managers to identify the risk of WPBR infection on a given site. We envision an interactive tool utilizing historic climatic data along with site-specific data provided by the user. The project has three stages. Firstly, we will investigate whether the microclimatic conditions created by vegetation management can significantly affect the risk of blister rust infection. Secondly, an interactive web-based hazard-rating tool will be developed that will allow the user to enter GPS co-ordinates and relevant site information (e.g., vegetation control, topography, soil characteristics, abundance of *Ribes*) and be advised of the risk of white pine blister rust and management options. Thirdly, field-testing and refinement of the model will occur to determine regional variations in prediction accuracy.

Methods for Stage One

The first stage in the development of this hazard-rating system is to determine the effects of herbaceous and shrub layer vegetation on conditions conducive to infection. Temperature and relative humidity occurring under various vegetation management regimes (i.e., herbaceous layer

controlled, shrub layer controlled, herbaceous and shrub layer controlled, untreated) will be measured near ground level (where >90% of infections occur) every 30 minutes from early July until late October. Soil texture, moisture and drainage will be recorded for each site in order to determine soil moisture evaporation as a source of humidity. Stages two and three of the project will follow in years 2004-2010.

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